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SECTION OF BIOLOGY*

APRIL 13, 1942

DOCTOR KEITH R. PORTER, Rockefeller Institute for Medical Research: *Developmental Variations Resulting from Various Associations of Frog Cytoplasms and Nuclei.* (This lecture was illustrated by lantern slides.)

The nuclei and cytoplasms of dividing or reproducing cells are commonly recognized as being mutually dependent, but the characteristics of the relationship are not known. During the early cleavage of the frog's egg, there is a pronounced increase in the number of nuclei and the total quantity of nuclear material. The materials for this duplication of nuclei are apparently derived from the cytoplasm, but the processes involved, what, in fact, the nucleus contributes to or receives from the cytoplasm, what characteristics of the one determine how the other shall react, are examples of questions for the answering of which there is little available information. It was to examine materials and methods

*The Section of Geology and Mineralogy met April sixth. No abstract was received from Professor Kirk Bryan, who gave an address entitled, "The Geologic Antiquity of Man in North America," illustrated by lantern slides.

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which might provide at least a possible approach to the investigation of problems such as these that the experiments to be described were undertaken.

The method employed is that often used in examining the relationship between two coexisting entities—one is varied while the other is kept constant. Following insemination of the frog's egg, the egg nucleus can be successfully removed and the egg cytoplasm is left with only the sperm nucleus present and functional. If sperm from a variety of species or races are used for insemination, it is obvious that a single type of cytoplasm can be combined with a variety of nuclei. By the same procedure, the cytoplasms can be varied and the nucleus kept constant.[1] The resulting embryos develop with only one-half the normal number of chromosomes, and are referred to as androgenetic heterospermic haploids. The developmental picture, the early embryology of these haploids, becomes for these experiments the index in terms of which the nuclear or cytoplasmic differences are described.

When the nucleus and cytoplasm which are brought together to form a heterospermic haploid are derived from distinctly different species, development generally ceases at a very early stage. This has been demonstrated in the investigations of Boveri, G. Hertwig, P. Hertwig, Baltzer, Horstadius, and several others. It was therefore of some interest to find that germ cell nuclei and cytoplasms derived from two distinct forms of frog occurring separately in northern Vermont and southeastern Pennsylvania, when combined reciprocally, yielded heterospermic haploid embryos which developed almost as well as the homospermic or control haploids, i.e., into swimming tadpoles. Such departures from the normal as were shown by these heterospermic haploids indicated the existence of differences (probably slight) between the germ cell nuclei and cytoplasms of the two forms. It was suggested that the two forms used were not distinct species, but

[1] Control of nuclear or cytoplasmic variation is at present limited to a selection of sources from which the nuclei or cytoplasms are derived. Since methods are not available by which controlled changes can be made in nuclei and cytoplasms, it is necessary to seek naturally occurring variations and to attempt to determine their character.

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races of the same species, best called *Rana pipiens*, and that the nuclear and cytoplasmic dissimilarities which found expression in the early development of the heterospermic haploids might be related to differences of an adaptational character which permitted the egg of the Pennsylvania form to develop over a different (higher) temperature range. This latter possibility suggested that between the Pennsylvania form and still more southern dwelling forms of this same type of frog, differences similar to those found between Pennsylvania and Vermont forms might be demonstrable. It has been shown that a Pennsylvania nucleus in Vermont egg cytoplasm, *(vt.)pa.*, produced an embryo with abnormally large anterior structures. Would the combination of a nucleus from a Florida form and Pennsylvania cytoplasm, *(pa.)fla.* show a similar departure from the normal?

The sources of the more southern forms were largely determined by the locations of frog dealers. Hence southern Louisiana and southern Florida provided two additional forms. Nuclei and cytoplasms from the four sources,—Vermont, Pennsylvania, Louisiana, and Florida, were combined in all possible ways, and the development of the heterospermic and homospermic control haploids was carefully followed and compared.

The forms of leopard frog used are quite similar and replace each other geographically. Laboratory tests of hybridizability have shown that adult diploid hybrids develop from all combinations, and that these hybrids are fertile. For these reasons and others, the four forms are considered as representing geographic races of the same species.

The results of combining the various sperm nuclei and egg cytoplasms can be summarized by a few generalizations:

1. If the nucleus used is derived from a more southern race than that from which the cytoplasm is obtained, the heterospermic haploid embryo develops with abnormally large anterior structures. This answers in the affirmative the query made above, i.e., the *(pa.)fla.* embryo shows abnormalities similar to those shown by *(vt.)pa.* If, on the other hand, the reciprocal combination is made, if the nucleus is derived from a more northern

race than the cytoplasm, the anterior embryonic structures are abnormally small. Thus, reciprocal combinations of nuclei and cytoplams from the same two races depart from the normal in apparently opposite directions.

2. It is roughly true that the more widely separated in a north-south direction the sources from which the combined nucleus and cytoplasm are derived, or perhaps more exactly, the greater the climatic difference between the sources, the greater the departure from the normal shown by the resulting embryo.

3. If a series of four embryos, all having the same type of nucleus but different cytoplasms, are compared relative to the size or form of the same embryological structure, it is observed that they can be arranged in a gradient of size or form which roughly parallels the north to south or climatic distribution gradient of the sources. This similarity in type of abnormality, with differences chiefly in degree, seems to suggest that the cytoplasms differ not so much in actual components as in, perhaps, the physical characteristics of the same components. Furthermore, in whatever respect the cytoplasms differ, the demonstrated differences would appear to be related to the north to south geophraphic distribution of the sources.

4. The same statements made above, under 3, relative to cytoplasmic differences can be made relative to nuclear differences.

5. The control embryos are observed to be almost identical in their development. Up to now, comparison of them has yielded no common differences which can be related to differences shown by the hybrids.

6. Cytological examination of the hybrids reveals, in addition to embryological dissimilarities, clear differences in mitotic activity. For example, a Florida race nucleus in Vermont cytoplasm divides much more rapidly during early development than does the Vermont nucleus in Florida cytoplasm.

Certain nuclear and cytoplasmic factors or components involved in early development and in determining rate of nuclear division, having been shown to differ in the germ cells of these four races, it becomes of interest and importance to consider the

possible nature of the differences. Among such differences as are known to exist between these germ cells, those which represent adaptation to the different environmental temperature conditions seem most significant. The eggs, for example, are prepared to develop at quite different temperatures, low for the northern race and progressively higher for the more southern races. If this fact is considered in conjunction with the obvious parallelism which, as mentioned above, apparently exists between the demonstrated gradient of nuclear and cytoplasmic differences and the gradient of north to south or climatic distribution of the races, it is difficult to avoid the assumption that the factors involved may differ in their temperature characteristics. It is possible that further examination of the material will confirm or deny this assumption and reveal whether or not the material is capable of yielding any precise information on the relative roles of nucleus and cytoplasm in dividing cells.

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SECTION OF PSYCHOLOGY

APRIL 20, 1942

DOCTOR LIVINGSTON WELCH, Institute for Research in Child Psychology, Hunter College: *Some Aspects of the Development of Inductive Reasoning.* (This lecture was illustrated by lantern slides and motion picture film.)

INTRODUCTION AND METHOD

A formal definition of inductive reasoning can be presented in the short proposition, "A process of arriving at generalization from particular cases." An investigation, however, of what circumstances and abilities contribute to success in a reasoning situation, covers almost the entire field of psychology. Memory, emotional stability, interest, persistence are some of the major factors which have a direct bearing on this problem. All of these make it possible for the reasoner, among other things, to perceive certain essential similarities—to group together or to generalize certain essential characteristics and relationships. This brings up the question as to what kinds of generalization the reasoner may be required to make in dealing with the principle of inductive reasoning. Such a list would be almost endless and by itself might tell us very little. Any answer to this question, in whole or in part, requires a departure from speculative to experimental inquiry.

During the past three years, Dr. Louis Long of City College and I have been conducting a series of experiments concerned with a limited number of these factors which influence generalizing in the field of inductive reasoning, between the ages of 3 to 13 years. In all instances, the procedure began with a matrix problem which made use of concrete material and required the application of Mill's Joint Method of Agreement and Difference. The relationship under investigation was between cause and effect. On the board of the apparatus there were three rows. Two blocks with

plugs were inserted simultaneously into the holes of each row. When the experimenter had finished his demonstration the bulbs in two of the three rows were lighted. The causal blocks responsible for the light were the blocks with the same picture of an animal found in the two lighted rows and absent from the row that was not lighted. This reasoning situation is comparable to one of the many classic problems which required the use of Mill's Method of Agreement and Difference—the discovery of the cause of yellow fever. The one factor preceding all cases of yellow fever and absent in all instances where the fever did not develop was the bite of a certain type of mosquito.

During the maximum number of 30 trials of the matrix problem, account was taken of the types of hypotheses the subjects employed in their attempts to arrive at a solution and of their success in verbalizing the principle after they had discovered it.

Successful subjects were given the opportunity to generalize the same principle, when the original blocks with pictures of different species of animals were substituted by those of different colors. Later, the children were called upon to generalize the principle to a similar situation where the phenomenon of color was substituted by that of direction.

In another series, the children were given material of varying degrees of abstractness. An illustration of a causal factor at the original object level would be blocks which had the same photograph of a horse in the two rows with lights. At the first level of abstractness, the causal blocks might be those which had pictures of different animals, members of the class of animals, while, at the second level of abstractness, the causal blocks might be a horse and a woman, members of the class of living beings. At this last level, the classes involved were the class of living beings (animals and people), the class of food (vegetables and fruits), and the class of vehicles (boats and land vehicles).

All of the problems so far described involve the use of three dimensional material. Our next investigation concerned the children's ability to generalize the principle from three dimen-

sional material to pictorial material, and, lastly, to language material. The pictorial material consisted of photographs of six different kinds of vegetables in place of six different species of animals on separate blocks. In each trial, three of these were presented in pairs of two, three rows deep. Opposite each of the three rows were pictures of a girl. Two of these presented the girl sick in bed. The third showed her jumping a rope. The general set-up was the same as that of the block form and block color problems.

The linguistic material was presented in the form of a paper and pencil test. This series made use of different types of foods, while the effect was illness in two out of three instances. Each problem was printed in three rows—two kinds of food which were followed by illness in two instances and not in the third instance. The antecedents in this series were increased from two to three, and then to four. These linguistic problems also include those involving two levels of abstract concepts. For example, if originally oysters were responsible for illness, at the first level of abstractness the cause might be two species of shell fish, while at the second level of abstractness it might be any species of fish. The last type of problems in this series involved both an increase in the number of antecedents and in abstractness.

Results

1. *Some Causes of Reasoning Failure:*

(a) It often happened that the child focused his attention on the wrong section of the apparatus. In some instances 15 to 20 trials were given before he shifted his attention to that part of the board where the solution of the problem might be found.

(b) Another factor related to the classifications used in the hierarchy tests. Decrease in the scores of the 2nd hierarchy were sometimes caused by cross classifications of the 1st hierarchy concepts. For example, a bus might be picked as the causal factor because a man rides in an automobile, the lights being on in the rows containing these 2 blocks. The correct solution would be a row boat, because the automobile and the battleship are in rows

with lights, whereas the selection of the choice block of the boy would be incorrect, because a horse is in the row without a light.

2. *Relationship between I. Q. and Reasoning.*

The correlation in all instances between I. Q. and reasoning was very low. The correlation between M. A. and reasoning, when C. A. was removed, and also the correlation between C. A. and reasoning, when M. A. was removed, were likewise low. Still the general results indicate that a child has to have a certain amount of C. A., and all that this implies in terms of experience, before he is capable of solving the type of problem used in this test.

3. Discovery of the principle in its original form, in the majority of cases, was not possible before 9 or 10 years of age. Children at this age and older were more resourceful in thinking up new hypotheses and were quicker to abandon an unsuccessful hypothesis than the children from 3 to 6 years of age.

4. Success in generalizing the principle when the characteristic of form was substituted by other phenomena and media made up the sequence color, pictures, words, direction—in this descending order of success.

5. Generalizing the principle, however, from three dimensional material to pictorial and language material was not as difficult for the subjects as generalizing to material that involved abstract concepts. Success in connection with this factor increased with age. In a marked degree this was first prominent from 10 to 11 years of age.

6. An increase in abstractness caused greater difficulty than an increase in the number of antecedents, while still greater difficulty resulted from a simultaneous increase of both these factors.

7. Lastly, while many children solve these problems without being able to give an adequate explanation of the principle, superior performance in generalization was given by those who verbalized adequately.

SECTION OF ANTHROPOLOGY

April 27, 1942

Doctor Eliot D. Chapple, Harvard University: *The Measurement of Interpersonal Behaviour.* (This lecture was illustrated by slides.)

The measurement of human relations arose, some five years ago, as a result of certain difficulties which Dr. Arensberg, who had a hand in developing these methods, and I experienced in trying to analyze our field observations and interviews.

As anthropologists, we were concerned with trying to understand what people did by watching their behaviour and listening to what they said. To help our understanding, we used terms like solidarity, integration, superordination and subordination, social mobility, anomie, Oedipus complex and repression. Ten years ago, we firmly believed that these terms were perfectly clear and that their meanings were equally clear to others.

After several years of work on our material, we gradually came to realize that all these terms were, for us at least, subjective in character. When we came upon a case we had labelled solidarity in the family, for example, and another which we regarded as an example of solidarity in the church, we found it rather hard to know what they had in common. Moreover, when we asked ourselves how we recognized solidarity even in the single instance, we found that we were depending upon our interpretation of particular words or actions which, in another case, we might not treat in the same way.

So we began to ask ourselves, what are the stigmata by which we recognize solidarity or superordination in the relations of people? It was clear that each of these qualities varied in amount under different conditions. Could we get some kind of crude measuring rod by which the amount of solidarity, for example, could be estimated and compared from relationship to relationship? Going back over our best material, that is, over

those cases which we intuitively felt made the most sense, we found that, in a rough approximation, the length of time that two people were together seemed to determine the degree of their solidarity. But this length of time could itself be broken up in several ways, in terms of the length of each event between the two of them, the frequency with which these events occurred, and so on.

We then began to test this idea out on our material and on cases from the literature, and we saw that it afforded us an objective method of determining the "strength" of relationships. Moreover, we also began to understand the significance of the techniques and activities which make up what the anthropologist calls the culture of a people. We saw that the performance of these routines determined which people should come together and for how long, and provided the framework for the habitual system of relations making up the social organization of a people. The kinds of situations which anthropologists describe under such headings as patrilocal residence, joking relationships, mother-in-law tabus, and so forth, could be given a quantitative value in terms of the number, frequency and duration of events between specific people.

When we turned to other terms we had found of great subjective value, such as superordination and subordination, we saw that these, too, could be defined objectively. The superior person was he who started action in an event, and the person having the highest degree of superiority was he who initiated action for all the members of his group with a high frequency. We found it convenient to differentiate between events involving only two persons from those in which more than two were involved, since the latter type were those which defined lines of authority. In this case, as in the previous one, we found that the cultural techniques determined, in part, who was to initiate action and to what people; whether it was in the routines of preparing meals, working in an assembly line, or conducting meetings. Ceremonies and rituals, from this point of view, were not merely of interest from the symbolic aspect, they had greater significance in

that they provided specific persons an opportunity to get responses out of others.

Finally, in the course of this crude beginning, we began to see that individuals themselves differed in their capacity to initiate action, in the amount of time they spent with others, etc. In other words, there were marked differences between individuals in this aspect of what is called their personalities.

Once we could apply these kinds of measurements to the relations of persons, once we had defined for ourselves these operations of frequency and duration of events, initiations of action, and the like, we discovered that our own material was only occasionally adequate for this kind of analysis. We then began to make new observations in factories and other small groups in order to test these methods for ourselves. It very soon occurred to us, after some field experience, that it would be a great help to an observer if he could eliminate notebook, pencil and stopwatch and make his observations mechanically. Accordingly, we devised the first of several instruments with which we have been able to measure human relations.

In passing, however, it may be worth mentioning that once we began to define our measurements, the old terminology began to drop out. This was not done deliberately. We found, not merely that it was more convenient to use terms which referred to the operations used, but also that the old terms could only be applied after an inordinate amount of time had been spent in explaining how we defined them Since the result of such an explanation usually was that the explainee complained bitterly, "That's not what I mean by superordination," we found it easier on everyone to give up the attempt. The chief loss has been that we have not been able to provide any bridge from the old terminology to the new for those who like to move by easy stages. In any case, the important thing is the development of operations by which the relations of individuals and groups of individuals can be measured, for from them, an operational account of society is possible.

Once you turn from a rough description of the length of time

two people are together and try to record what goes on during the event between them, you are compelled by the nature of the material to record their interaction. By interaction, I mean the alternation of action and inaction by an individual, ordinarily manifested in the presence of other individuals, in such a way that, in a rough approximation, the action of one individual occurs during the period the other is not acting. Both actions and inactions may be as short as a fraction of a second. In the ordinary non-pathological individual, they may last several minutes. The actions may be vocal or non-vocal or both. In the human, they consist essentially of speech and gestures. The measurement of the interaction of two or more persons involves recording the length of each action and inaction for each person, and then measuring the degree to which these action-inaction sequences are synchronized.

The recording machine consists essentially of a moving tape driven at a uniform rate of speed on which lines are drawn when the observer presses a key. When a person starts to act, the observer presses down the key assigned to that person and holds it down until he stops acting, when the key is released. Each other person is treated in the same way. From a tape for two persons, we are able to measure off not only the length of each action and inaction, but also the length of each interruption as well as the length of time that one fails to respond to the other. We also know which person was responsible for the interruption or failure to respond, and which of the two outacted the other after an interruption, and which, after a period when both were inactive, initiated the action.

In the series of measurements reported on, consisting of normal individuals and patients from the psychiatric ward and out-patient clinic of the Massachusetts General Hospital, we were primarily concerned with the interaction of members of pairs, and only incidentally mentioned our work with more than two individuals. We concentrated on pair-relations because they are the most frequently occurring type, and because we wanted to discover the differences that individuals exhibited in their capa-

city for interaction. By so doing, we would be able to define the properties of the principal building-block of organizations,—the relation between two persons. Once this had been defined, the more complex case involving three or more individuals could then be dealt with.

Each set of measurements has been described by the use of an alternating series. An alternating series is made up of a sequence of alternately positive and negative terms which is summed cumulatively. If we let the actions be positive and the silences or inactions negative, then the relative length of action to silence determines the slope of the curve (given an arbitrary value for each term of the series on the abcissa).

The use of the alternating series is based upon the assumption that the amount of activity and inactivity of an individual is constant within limits. If there is an increase at one period during the day, there will be a decrease at another, and this assumption is based upon physiological evidence to be referred to later. Since the interactional situation requires an alternation between action by one individual and action by the other, some kind of balance has to be obtained in the durations of activity manifested by each individual. The alternating series provides a continuous measure of the changes in this output from individual to individual and of the adjustments which each has to make to the other.

Four curves are constructed for each individual from each observation, all consisting of alternating series. The first is the activity curve,—the individual's actions minus his silences. The second consists of the individual's interruptions of the other person minus his failures to respond to the other person,—his adjustment curve. The third consists of the other person's interruptions minus his failures to respond. The fourth, called the initiative curve, consists of a numerical count of the individual's continuations of action after an interruption (when the other person becomes silent) plus his initiations of action after both are silent *minus* the other person's continuations of action together with his initiations of action.

In the series of observations reported upon, marked differences were found both between normal and abnormal individuals as well as between normals themselves and the abnormals themselves. Dealing with the abnormal patients first, the manic individuals were characterized by very steep positive activity slopes, while the psychotic depressions had equally steep negative slopes, on the average over 85 degrees. In the manic, the adjustment curve of the patient was positive, indicating consistent interruption of the doctor. In the depression, the adjustment curve was negative, showing pronounced latency of response.

Schizophrenic patients showed moderate activity curves, with many instances of marked drops to negative values, while the patient's adjustment showed marked negative adjustment curves, showing the characteristic latency of response. The difference between the depression and the schizophrenic lies in the relationship of the activity and adjustment curves. In the former, the activity curve lies at a greater negative angle than the adjustment curve. In the latter, the position is reversed, and the activity curve is very frequently positive in value. The final instance of psychosis illustrated was that of the paranoid state, in which alternations between high activity and marked inactivity seemed to be characteristic without any pronounced latency of response.

Four types of psychoneurosis were illustrated,—hysteria, anxiety, obsession and depression. In these instances, the activity curve moved progressively from positive to negative values; the hysterias showing marked activity, between 80 and 84 degrees of slope; the anxieties varying around 45 degrees positive; the obsessions showing similar negative values, and the reactive depressions negative values similar to those in hysteria.

Characteristic of all the psychoses and psychoneuroses was the lack of adjustment as measure by the occurrence of interruptions and failures to respond, with the normal individual exhibiting a high frequency of periods in which neither interruption or failure to respond occurred. Also characteristic of the normal individual was a greater variability in the activity slopes. The

abnormal individuals present day after day approximately the same values. The normal individuals vary widely in their activity rates, although that variation occurs within well-defined limits. Moreover, different individuals suffering from a given ailment show little variation between themselves, unlike the normals.

In a series of over 250 normals, we have found that the extreme activity slopes of the manics, hysterics, psychotic and reactive depressions do not occur. In all cases, patients so diagnosed showed far steeper slopes negatively or positively than those found in normal individuals. All other types, paranoias, schizophrenias, anxieties, obsessions, fall within normal limits on the activity curves. Diagnostic criteria in these latter cases are dependent upon the shape of the activity curve and, in particular, upon the interrelations of the other curves with each other and the activity curve.

Several instances of psychosomatic disorders were also illustrated to show the variations in interaction rates obtained under such conditions. The push of activity in a patient with a history of migraine, having a neuro-angiotic edema, and the depression-like curve obtained in ulcerative colitis were shown, together with an instance of an individual recovering from the latter ailment who had an activity curve comparable to that found in anxieties.

Experimental modifications of these curves were shown. First, through changes in the interaction rates of the interviewer and, second, by the use of drugs affecting the autonomic system. In the latter case, mecholyl produced a marked increase in the activity rate of a normally active person, while adrenalin changed the activity to a definitely negative slope on the order of that produced in the depressions.

Finally, differences in individuals having the same activity rate were shown based upon the length of the units of interaction (made up of an action and subsequent inaction), so that we obtained a measure of the relative speed with which a given amount of activity was produced; and also differences in the capacity of individuals to obtain responses from groups of individuals, which

provide one with an effective measure of leadership in terms of interaction.

Discussion

The study of interaction is only a part of the wider study of the activity of organisms, which may be divided into two major subjects: first, the study of spontaneous activity, that is, activity manifested by the organism under constant environmental conditions; and, second, the study of the activity which represents a response to changes in the environment. Studies of the lower animals by Stier (1930), Crozier (1934), Richter (1922, 1927), Wolf (1930), and many others have shown that spontaneous activity has a rhythmic character, and that its rate is specific to different pure stocks. A number of studies have also shown that the amount of activity manifested by an animal is constant within well-defined limits. Skinner (1933), in his study of the adult rat, showed that if activity was prohibited during part of the day, the remaining part of the day showed a greater density of activity per unit time.

In the mammals, changes in the distribution of the basic activity rhythms seem to result from adjustments to the environment consequent upon the operation of the autonomic nervous system. Boldyreff (1916), Wada (1922) and others have shown the relationship of bursts of activity to the hunger cycle, and analysis of the data on changes in motor activity resulting from disturbances of the autonomic nervous system shows that these are coincident with other changes in sympathetic and parasympathetic functioning. These changes are ordinarily the result of changes in the environment, and, as we know, the bulk of these disturbing situations come from other animals. Indeed, the ordinary procedure used in studying autonomic changes in the cat is to tie the animal to a board and then bring a dog into the room. The interaction which then results is sufficient to bring about the sympathetic reactions which Cannon (1936), Bard (1934) and others have described.

In interaction, therefore, we have two factors, the basic

activity rhythms specific to the organism which make up what is called spontaneous activity and the changes in that activity consequent upon the responses brought about by the actions of other animals.

Interaction is, after all, only a conditioned form of the basic activity pattern. The infant animal, whether mouse or human, is unable to interact. He learns to do so only as a result of having to respond to the actions of others. Many observers have described how animals learn to interact. Carpenter (1934), for example, has recorded many incidents in which the mother conditions the infant to respond to her actions, and all of us who have children know well the long process of dangling rattles, calling the baby's name, etc., by which we get the child to respond automatically to our actions and to adjust his actions to ours.

Although activity is controlled by centers below the cortex, as is shown by observations of decorticate and decerebrate animals, interaction itself is a cortical pattern, since we know that under conditions inhibiting cortical control, the capacity to interact is markedly altered. These include states of strong emotion, the influence of alcohol or sodium amytol, in general paresis, and in many types of brain lesions. My colleagues, Lindemann and Finesinger (1938), have shown how drugs affecting the autonomic nervous system change the objective aspects of speech production.

The significance of this physiological evidence lies in the fact that it provides us with an understanding of the mechanisms which control the interactions of individuals. When we deal with human relations, therefore, we are not limited to statements about "emotion" or "sentiments" with which to describe adjustment or the lack of it. We are able to measure this adjustment and understand the mechanisms which control its changes.

Some Applications

The utility of measurements of human relations from the clinical point of view is clear, although we have by no means explored all its possibilities. We are able, at the very least, to make explicit many of the intuitive judgments of the clinicians, and to

give quantitative definitions to cases of psychogenic disorders. In other areas, these methods promise to have great value.

In the field of selection of personnel, for example, the measurement of human relations seems to have even greater usefulness, since it can there be used to increase the effective working relations of large groups of people. Not only is it possible to differentiate the normal from the abnormal person in an employment interview and thus to keep the behaviourally unstable out of an organization; it is also possible to select individuals for different positions who will be able to adjust to the persons with whom they have to work. First, take the measurement of the capacity for leadership as defined by the ability to obtain responses from a group of other individuals and to maintain that leadership continuously. Not only is it necessary in choosing individuals for executive positions to get people who actually can lead, but also to select leaders who will fit the requirements of the interactional situation in the organization. A man who will make a good leader on a ship or in a construction gang will rarely be able to reduce his rate of initiations to be effective as head of a research laboratory. Second, the capacity for adjustment differs in different individuals. Some persons can get along well with a large number of individuals who differ markedly in their interaction rates. Other persons can adjust well only to people with high activity rates, or conversely. Third, individuals vary widely in the speed with which they interact. Two persons having the same activity rate can have markedly different speeds at which they interact, some being slow and deliberate, other fast and quick-acting. The requirements of different jobs differ markedly in the amount of speed required. Slow-acting persons in a fast-acting team will upset the group, who have to adjust their rates on a different level than that to which they have been accustomed. Fourth, the degree of initiative shown is of great importance in selecting personnel for different types of jobs. People without a high rate of initiations make poor salesmen, for example. Fifth, the activity curve itself will determine the degree to which an individual is able to have a high frequency of contacts with others. People with low activity

rates make poor executives, unless the job requires little interaction with others.

In the long run, however, the study of the interactional properties of the individual which makes up what we ordinarily call his personality, is only important in so far as it contributes the understanding of the relations of individuals in institutions, of the way in which organizations actually operate. Organization problems are, after all, our basic concern, because in organizations, whether family, factory, church, club or government, most of our existence is passed. The degree to which organizations operate effectively has, therefore, an enormous importance for ourselves, and the solution of the difficulties which arise within organizations depends upon the degree to which we are able to define them objectively.

It was for this that these methods of measuring human relations were developed. The study of organization is essentially the study of the relations of personalities to one another within the framework provided by the routine activities of the organization in question. These activities, as I pointed out earlier, determine to a large degree who shall initiate action and who shall interact, and upon their capacities for adjustment to one another depends the working efficiency of the organization. This is the field which many anthropologists call the field of culture and personality, and it is here that the measurement of human relations promises to be of the greatest value.

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Elected April 23, 1942

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